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ABSTRACT

This paper indicates the increasing interest and importance of research on the effects of attitudes toward learning, and examines the differences in attitudes by gender, ethnicity, and grade level among middle school students toward science. It was concluded that sex differences provide a constant influence on attitudes toward science, and that ethnicity affects student choices in the courses of biology, chemistry, and physics. The awareness of teachers about their students' attitudes toward science can help them in developing programs and curriculum designs to better aid these students. (Contains 22 references.) (YDS)

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by

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GENDER, ETHNICITY, AND GRADE LEVEL AS PREDICTORS OF MIDDLE SCHOOL STUDENTS' ATTITUDES TOWARD SCIENCE

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Interest in how attitudes toward science are formed, and how they affect learning, school course selection, and personal, civic, and work choices, has been increasing for the past thirty years. There are several reasons why research on students' attitudes toward science is important. First, attitudes toward science are believed to influence behaviors, such as selecting courses, visiting museums, and supporting scientific inquiry (Kaballa & Crowley, 1985). Second, a relationship between attitudes and achievement has been shown to exist. Schibeci and Riley (1986) report that there is support for the proposition that attitudes influence achievement, rather than achievement influencing attitudes. Students with positive attitudes toward science tend to have higher scores on achievement measures (Oliver & Simpson, 1988; Weinburgh, 1994). Third, nationwide assessments of attitudes toward science indicate that, by third grade, fifty percent of students are not interested in science. How America is Shortchanging Girls (AAUW, 1992) graphically points out that many students, especially females, associate science with negative feelings and attitudes which discourage them from continuing with scientific inquiry. Having established these three reasons for the importance of student attitudes toward science, science educators can no longer assume that students will acquire positive attitudes simply because they are required to take additional science courses. Research that attempts to discover which variables most influence attitudes toward science is necessary so that appropriate intervention can be planned.

Research indicates that males have a more positive attitude toward science, are more highly motivated to achieve in science, and more likely to select science courses as electives in high school (Hykle, 1993). Schibeci (1984) reported that of all the variables that may influence attitude toward science, gender has generally been shown to have a consistent influence.

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Simpson and Oliver (1985), in an ongoing multidimensional study among 4,000 students in grades 6 through 10, found that males show significantly more positive attitudes towards science than females. Although females make up one half of the workforce, only about 15% of U. S. mathematicians, scientists, and engineers are females. In fact, even though scientific thinking is of value to everyone, that scientific jobs pay almost 50% more than non-scientific ones requiring the same degree of education, and that people trained in scientific thought are increasingly needed in today's society, there has been a drop in the total number of Americans preparing for scientific careers in the last few years (Chapman,1997).

There is not a lot of research on student attitudes as influenced by ethnicity AAUW, 1992). However, ethnic differences in science course selection are pronounced (NSF,1996). African American students are as likely as white students to take biology in high school but much less likely to take chemistry or physics. In addition, differences in achievement by ethnicity are more pronounced than differences by gender. Scores for whites are substantially higher than those for African Americans (NSF, 1996).

Kahle and Lakes (1983) suggest that the lack of positive attitudes toward science by females begins in the elementary grades. However, in a study of 1,200 students enrolled in grades four through six, Pogge (1986) found that students have a positive attitude toward science. The Sadkers (1986) report that gender differences are more pronounced in middle school, while Weinburgh (1994) reports that they continue into high school and that grade level is a significant predictor of student attitudes toward science.

Purpose

The purpose of this study was to examine differences by gender, ethnicity, and grade level in middle school students' attitudes toward science. The main questions being asked in this study are: 1. Do middle grades students exhibit different attitudes toward science according to gender?

2. Do middle grades students exhibit different attitudes toward science according to ethnicity?

3 .Do middle grades students exhibit different attitudes toward science according to grade level?

Method

Subject

The inventory was given to 1,381 students, 680 males and 697 females and 4 not coded. The racial composition was 458 (33%) African American, 94 (7%) Asian, 576 (42%) White, 102 (8%) Hispanic, 33 (2%) Native American 91 (6%) Other, and 27 (2%) not marked. There were 337 sixth grade students, 563 seventh grade students, and 475 eighth grade students. Because of the low numbers of Asian, Hispanic, Native American, and Other students, the sample was reduced to include on the African American and White students. This produced a sample of 1034, with 517 males and 517 females, 468 African Americans and 576 Whites, and 237 sixth graders, 416 seventh graders, and 376 eighth graders. The students were from six schools in two suburban school districts in the Southeast. All students were proficient English speakers.

Instrument

The Attitude Toward Science Inventory: Version A (ATSI) was used to examine the students' attitudes toward science. One reason this instrument was selected is because of the high construct validity reported by Goglin and Swartz (1992) and Weinburgh (1994), and the high content validity reported for the mathematics version by Sandman (1973). Another reason for selecting this instrument was because of its multidimensional nature. The ATSI is a 48-item inventory which consists of six scales with eight statements: perception of the science teacher, anxiety toward science, value of science in society, self-concept in science, enjoyment of science, and motivation in science. A four point Likert scale was used in order to force the student to strongly agree, agree, disagree or strongly disagree with each statement. The alpha reliability coefficients for gender ranges from 0.66 to 0.82, for ethnicity from 0.56 to 0.83, and for grade level from 0.63 to 0.84. These are within the range of acceptability (Nunnelly, 1967).

Procedure

Students were administered the ATSI during the science period, or home room, at the end of the first grading period. The teachers were given verbal and written instructions on the

procedures for administering the instrument in order that the conditions be as similar as possible in each testing site. Students were asked to circle the number of the response on the instrument that best described their feeling toward the statement at the moment.

The first step after data entry was to reverse the scoring of negatively worded items in all scales except anxiety. For this scale the positively worded items were reversed. The student responses to each scale were tallied to give each student six attitudinal scale scores: possible scores on each scale ranged from 8 (indicating all negative responses) to 32 (indicating all positive responses), except for the anxiety scale which is the opposite.

Descriptive statistics were calculated. A MANOVA was run in order to determine if there was a difference by gender, ethnicity, and grade level. No interactions were significant but all three main effects were significant at the _ = .05 level (gender $F(6,1012) = 4.74$; $p < .01$, ethnicity $F(6, 1012) = 2.31$; $p < .05$, grade level $F(12,2026) = 8.85$; $p < .01$). Having found a significant MANOVA, an ANOVA was run for each attitudinal scale to assess its relationship with each of the independent variables of gender, ethnicity, and grade level.

Results

Gender

Student attitudes by gender vary on the different scales. Females have more positive attitudes toward the teacher and the value to society and are less anxious. Males have more positive attitudes toward self-concept in science, enjoyment of science, and motivation in science. Although only two of the scales are statistically significant (teacher, $p<.01$, in favor of females and enjoy, $p<.05$, in favor of male), all of the scales differ significantly from neutral.

Ethnicity

An ANOVA showed that five scales were significant at the _ = .05 level. Motivation was not significant ($p=.054$). The white students were significantly more positive than the African-American students on the teacher, value, self-concept, and enjoy scales, and less anxious about science. The scales showing the greatest degree of difference were perception of teacher, value, and self-concept.

Table 1
Means for the Six Subscales of the Attitudes Toward Science Inventory (Neutrality = 20) by Gender.

Subscale of ATSI	Male	Female	F
Perception of Science Teacher	23.8	24.6	7.04**
Anxiety toward Science	16.7	16.6	0.19
Value of Science	23.6	23.8	0.82
Self-Concept in Science	23.3	23.2	0.12
Enjoyment of Science	21.9	21.2	4.65*
Motivation in Science	20.2	20.1	0.14

Note: * $p < .05$, ** $p < .01$.

Table 2
Means for the Six Subscales of the Attitudes Toward Science Inventory by Ethnicity (Neutrality = 20).

Subscale of ATSI	African-American	White	F
Perception of Science Teacher	23.6	24.6	13.80 **
Anxiety toward Science	17.2	16.3	13.10 **
Value of Science	23.3	24.1	11.04 **
Self-Concept in Science	22.8	23.7	12.38 **
Enjoyment of Science	21.1	22.0	9.68 **
Motivation in Science	19.9	20.4	3.71

Note: * $p < .05$, ** $p < .01$.

Grade Level

Five of the six scales were significant at the _ = .05 level. All differed significantly from neutrality (neutral = 20). On every scale students showed less positive attitudes as they continued in school. The 6th grade students showed more positive attitudes than the 7th grade, the 7th grade showed more positive than the 8th grade. Motivation actually became less than neutral (mean of 19.8) for the 8th grade students. For three of the scales (teacher, value, and self-concept), the mean of 6th graders was above "agree" (agree = 24) as did the teacher scale for 7th graders.

Table 3
Means for the Six Subscales of the Attitudes Toward Science Inventory by Grade Level (Neutrality = 20) .

Subscale of ATSI	6th Grade	7th Grade	8th Grade	F
Perception of Science Teacher	25.5	24.6	22.9	30.94**
Anxiety toward Science	16.2	16.6	17.2	4.43*
Value of Science	24.5	23.8	23.1	8.33**
Self-Concept in Science	24.4	23.8	23.1	13.02**
Enjoyment of Science	22.1	22.0	21.0	4.48*
Motivation in Science	20.5	20.2	19.8	2.58

Note: * p < .05, ** p < .01.

Discussion

This study investigated gender, ethnicity, and grade level differences as predictors of student attitudes toward science. Six attitudinal scales were studied. Findings from this sample

indicate that gender is a significant predictor on student attitudes toward the teacher and enjoyment of science. Ethnicity and grade level are significant predictors for five scales.

Gender

Because there has been a slight decline in gender differences over the past decade, some people have suggested that gender inequality is no longer an issue in education (Catsambis, 1995). This study shows that of the three variables examined, gender does appeared to be the least predictive. As indicated by other studies, males have an overall more positive attitude toward science than do females. Gender is a significant predictor of the perception of the teacher and enjoyment. This agrees with earlier studies by Weinburgh (1994). However, it should be noted that males are more positive in their enjoyment of science, motivation in science, and self-concept of science whereas the females are more positive in their perception of the science teacher and the value of science to society. These are critical differences in how students feel about the whole concept of science. From this data, one might suggest that males are going to be more likely to continue with science than are females.

It has been suggested by Kahle and Lakes (1983) that social and cultural factors may contribute to the differences found in science attitude by gender. Responses to the NAEP show that males far out number females in early experiences with scientific activities and skills. This may help to explain why the males are more positive on the enjoyment of science scale. These findings agree with the research that indicate that females want to please, and therefore are more aware of the teacher, and of pleasing the teacher.

Ethnicity

The difference seen between African American students and white students is alarming. Traditionally, this population has had lower achievement scores (Schibeci & Riley, 1986) and have not pursued science degrees (Atwater & Wiggins, 1995). The lack of a positive attitude on five of the scales indicates that these students are not likely to continue selecting to take science courses as they move into high school. It is particularly unsettling that African American students have such low opinions of their teacher, the value of science in society, and enjoyment

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of science. This study contradicts Hill, Pettus, and Hedin (1990) who found that the main effect for race was higher for the total score and for teacher encouragement.

Grade level

The declining positive attitudes toward science found in this study are consistent with the findings of Hofstein, Maoz, & Rishpon (1990), Catsambis (1995), and Weinburgh (1994). This study indicates that grade level is a significant predictor on five of the scales. On all six scales, the mean declined with each grade level. These declines in the science attitudes could affect their achievement and learning opportunities during high school. The reason for the continued decline should be further examined. One explanation may due to the way that science is taught in the upper grades. Indications are that science is often taught as a group of facts and vocabulary words that are to be memorized and not as a way of investigation. It may be that the natural curiosity of children has been dampened as they move through the grades.

Implication

This study shows that more research is needed about students' attitudes and about what is happening in schools that would cause students to develop less positive attitudes over time. Researchers also need to look at how ethnicity affects students' attitudes toward science.

In addition, teachers need to be aware of the trends in student attitudes toward science by gender, ethnicity, and grade level. Knowing the results of studies such as this one may help in developing programs that address the needs of females and minority students as they study science. It may also help curriculum designers in producing science materials that help to capture the interest of students and keep them more interested in science. These efforts should being in the elementary grades. Several studies (Bredderman, 1982; Shymansky, Hedges, & Woodworth, 1990) indicate that elementary programs that involve inquiry-based, hands-on strategies increase the later science success of students. Inquiry-based science in middle grades may help to achieve the same affect.

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